FINAL
TECHNICAL MEMORANDUM
LOOK-UP TABLE RECOMMENDATIONS
SANTA SUSANA FIELD LABORATORY
AREA IV RADIOLOGICAL STUDY

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EXECUTIVE SUMMARY

Pursuant to an interagency agreement between the U.S. Department of Energy (DOE) and U.S. Environmental Protection Agency (USEPA), the USEPA has conducted a Radiological Background Study to determine the background levels for radionuclides in surface and subsurface soils associated with Area IV and the Northern Buffer Zone (Area IV Study Area[1]) of the Santa Susana Field Laboratory (SSFL), located in Ventura County, California. In addition, the USEPA is currently conducting a radiological characterization of the Area IV Study Area to identify areas that exhibit radionuclide concentrations in surface and subsurface soil and sediment above background levels (herein, "soil" shall mean surface and subsurface soil as well as surface and subsurface sediment unless otherwise specified).

This technical memorandum provides USEPA's recommendations to the State of California's Department of Toxic Substances Control (DTSC) regarding the future development of Look-up Table (LUT) values. LUT values are a metric against which analytical sample results will be compared to determine if a sample contains or does not contain contamination requiring remediation. In addition, guidance is provided for the implementation and application of these LUT values, and for addressing potential challenges in the procurement and use of analytical laboratory data. USEPA recommends the use of Background Threshold Values[2] (BTV) as the basis for development of LUT values for radiological contamination; for the reasons described herein, BTVs alone are neither appropriate nor recommended for use as the LUT values. BTVs were established during the USEPA's Radiological Background Study as summarized in Table 1 (Attachment 1).

[1]The "Area IV Study Area" is defined as the property including Area IV and the Northern Buffer Zone.
[2]BTVs are the upper limit of background activity for individual radionuclides.

BTVs are the basis for developing future LUT values.

USEPA recommends in cases where it is not practically or technologically feasible for the radioanalytical laboratory to provide data of a quality that supports the use of a specific BTV, the laboratory's detection limit[3] should be used as the acceptable alternative. This document includes recommendations on the selection of either BTVs or laboratory detection limits as cleanup levels[4] for soils in the Area IV Study Area.

USEPA recommends that DTSC establish decision criteria for comparison of laboratory results to the cleanup levels, which will assist in determining whether the cleanup levels have been exceeded. These decision criteria, called decision levels (DL), should take into account the quality of the laboratory's analytical data and DTSC's tolerance for errors in the decision making process. While DLs (called Radiological Trigger Levels [RTL] during USEPA's Area IV Radiological Study) have been developed for the USEPA's radiological investigation of the Area IV Study Area, those DLs are based on the quality of data procured specifically for that investigation and USEPA does not recommend the use of those DLs for future phases of the project. Rather, new DLs should be calculated based on the expected quality of future laboratory data. This document provides guidance for DTSC to calculate new DLs, hereafter called LUT values, after the procurement of future analytical laboratory services; therefore, these LUT values will be developed after the procurement.

USEPA's RTLs are not LUT values and should not be used by DTSC.

DTSC should develop new DLs as the LUT values.

USEPA provides the following recommendations for implementation of operational efficiencies during the remediation and site closure phases, based on outcomes and "lessons learned" from the Area IV Radiological Study:

- Focus on the comprehensive list of BTVs summarized in Table 1 on Priority One radionuclides (Section I of Table 1 and 2) that were detected in the Area IV Radiological Study at concentrations above USEPA's Radionuclide Reference Concentrations (RRC). See the explanation of the development and purpose of the RRCs in an appendix of the Final Radiological Characterization of Soils, which was in development when this technical memorandum was completed. This effort is expected to reduce analytical costs, accelerate the delivery of analytical data, and optimize

[3] Per the Administrative Order on Consent (AOC), detection limit means the minimum detectable activity. In all cases, minimum detectable activity is synonymous with minimum detectable concentration and the terms may be used interchangeably with detection limit.

[4]The BTVs are called "cleanup levels" after comparison to laboratory detection limits to distinguish the two step process of establishing LUT values.

overall data quality while achieving a cleanup level closer to the BTVs in compliance with the AOC.

Focus procurement of an analytical laboratory on Priority One radionuclides.

- Follow "best practices" in the procurement and management of laboratory services, including the specification of measurement quality objectives (MQO), optimizing method performance, and streamlining the data evaluation and decision making process.

1.0 INTRODUCTION

This technical memorandum provides USEPA's recommendations to DTSC regarding development of LUT values for radiological contamination in SSFL Area IV Study Area soil samples during further investigation, remediation and closure phases. The Administrative Order on Consent (AOC), an agreement between DOE and DTSC, is briefly discussed as the basis for the development of LUT values. The memorandum also includes recommendations regarding the lessons learned from the USEPA's Area IV Radiological Study regarding the use of cleanup levels, the selection of analytical laboratories, and the use of laboratory data. Finally, recommendations are included for the development of LUT values as criteria for comparison to future laboratory data.

1.1 ADMINISTRATIVE ORDER ON CONSENT

The AOC was issued under the regulatory authority of the DTSC and is a principal guiding document in the development of the Area IV Study Area remediation standards. The AOC is an agreement between DTSC and DOE. USEPA is not a party to the AOC, but has agreed to assist with limited activities pending funding from DOE. USEPA agreed to provide DTSC assistance on the development of LUT values. DTSC has the authority and responsibility to develop and approve final LUT values.

1.2 DEVELOPMENT OF BACKGROUND THRESHOLD VALUES

BTVs were determined during USEPA's SSFL Radiological Background Study. A detailed analysis of the development of the BTVs is included in the Final Radiological Background Study Report (HGL, 2011).

The background study included analyses of 149 surface and subsurface soil samples from areas that were not affected by SSFL site operations, and were representative of SSFL soil in geology and other physical characteristics. From the analytical data and extensive statistical analyses, BTVs were calculated as the 95 percent Upper Simultaneous Limit for 64 radionuclides of concern. The BTVs describe an upper limit of the level of radioactivity expected to be encountered in a background sample. This limit incorporates observed variability in the background radioactivity for each radionuclide, as well as the variability in the sampling and measurement processes used to characterize the background samples.

After the removal of 12 radionuclides for which the results were either redundant or otherwise technically problematic, 52 BTVs remain as the basis for calculating LUT values. The BTVs are summarized in Table 1 and, while they are the starting point for the calculation of LUT values, they are not appropriate for use by themselves as LUT values.

BTVs alone are not appropriate for use as LUT values.

1.3 THE DECISION MAKING PROCESS

In establishing statistical criteria for determining whether a BTV has been exceeded[5], it is important to formulate the null hypothesis in a manner that accurately reflects the quality of the available data. If the null hypothesis is that "the sample is assumed to exceed the BTV until it is shown to be otherwise" then Multi-Agency Radiological Laboratory Analytical Protocols (MARLAP) Scenario A defines the appropriate calculation for the LUT value. Alternately, if the null hypothesis is that "the sample is assumed not to exceed the BTV until it is shown to be otherwise", MARLAP Scenario B defines the appropriate calculation for the LUT value.

For this project data generally falls into one of two categories:

- Radionuclides for which the BTV is derived from background samples with no measurable activity. In this case there is no way to statistically distinguish a "clean" sample from the background samples that were used to derive the BTVs. Therefore, under the expected analytical conditions, no sample could be reliably determined to meet the acceptance criteria applicable to Scenario A, even after remediation.
- Radionuclides for which the BTV is derived from background samples with measurable activity. For these radionuclides, the BTVs are determined from the upper limit of a population of background results. Establishing a decision level below the BTV, as prescribed in Scenario A calculations, would result in a decision error rate that significantly exceeds the Scenario A design parameter.

For both cases described above, MARLAP Scenario B is applicable and the BTV is assumed not to have been exceeded until the analytical results exceeds the BTV by a margin that reflects the method uncertainty (U_M) at the BTV.

The decision making process requires the use of MARLAP Scenario B.

Regardless of the selection of Scenario A or Scenario B, the goal of the decision process remains the same; to determine whether the BTV, i.e. the cleanup level, has been exceeded. The selection of Scenario B is a necessary outcome of the project goal, which is to establish clean up levels that are equal to "background" levels.

[5]Data users who are unfamiliar with radiological data or with the MARLAP Manual (MARLAP; USEPA, 2004) Directed Planning and Data Quality Objectives Processes, which are reflected in this document and in the Area IV Radiological Study Quality Assurance Project Plan (HGL, 2012b), may benefit from a review of MARLAP, Appendix B, as well as Chapters 2 and 19.

1.3.1 The Impact of Method Uncertainty on the Decision Making Process

All measurements have some degree of inherent uncertainty. All radioanalytical methods should be evaluated to determine all significant sources of uncertainty. The cumulative effect of those uncertainty sources is U_M. U_M describes the range of true values that might be represented by a given laboratory result. U_M is an unavoidable aspect of the analytical method, is specific to the sampling and measurement processes used to characterize the Area IV samples, and is *independent* of the variability in the background results reflected in the development of BTVs.

For any given sample, a laboratory result that is equal to the BTV represents a range of possible true values for that sample; some of which are less than the BTV and some of which are greater than the BTV. Whether that result represents a true sample value that actually exceeds the BTV is purely a matter of chance; a decision that the BTV has been exceeded would be incorrect 50 percent of the time. Establishing a decision criterion, without considering the impact of U_M, would result in a potential situation in which the release of uncontaminated background-level material would not be assured, but would instead be randomly determined, similar to a coin toss.

1.3.2 The Impact of the AOC on the Decision Making Process

The AOC states, in pertinent part:

- The LUT will describe radiological cleanup levels that include local background concentrations as well as minimum detection limits, where appropriate and as described in Section 2.2 below.
- The analytical result, not adding or subtracting the analytical error, will be compared directly to the LUT values.

While DTSC may select LUT values that are equal to the cleanup levels, it is USEPA's understanding that the extraordinarily high decision error rate for laboratory results at or near those cleanup levels is believed to be unacceptable. In exercising independent technical judgement, as identified in Section 5.2 of the AOC, USEPA recommends an adjustment to the BTVs and minimum detectable concentrations (MDC) to include appropriate consideration for U_M to ensure an acceptably low decision error rate of approximately 5 percent. This adjustment is not believed by USEPA to be contrary to the AOC requirement that LUT values incorporate BTVs and laboratory MDCs[6]. Individual sample results would not be adjusted by adding or subtracting the reported sample-specific uncertainty, in keeping with the AOC requirements.

[6]The AOC is subject to interpretation and includes specific provision for DTSC and DOE to resolve any potential disputes in that interpretation.

1.3.3 Limiting U_M in the Laboratory Analytical Methods

To ensure that U_M is adequately restricted to provide meaningful decisions at the cleanup level, U_M must be constrained to a level that will support a pre-defined acceptable decision error rate. USEPA recommends a decision error rate of no more than 5 percent, which requires that the maximum U_M not exceed 10percent at the cleanup level.

Limiting U_M to a maximum level, in this case 10 percent, is accomplished by establishing a maximum required method uncertainty (U_{MR}) as an MQO, incorporated into the laboratory's statement of work (SOW). The nature of radioanalytical uncertainty requires that U_{MR} be defined in two parts; a maximum required *absolute* method uncertainty, U_{MR}, below a specified activity level and a maximum required *relative* method uncertainty (ϕ_{MR}), above the specified activity level.

The primary MQO applicable to the decision making process is that the U_{MR} should not exceed 10 percent of the BTV, for results at or below the BTV. For results above the BTV, the ϕ_{MR} should not exceed 10 percent of the result. In keeping with the requirements of the AOC, if laboratory MDCs exceed the BTV for a given radionuclide, the MDC is used in place of the BTV. The development of LUT values, described in Section 2.3, incorporates this rationale.

2.0 INTERPRETATION OF ANALYTICAL LABORATORY DATA

The use of BTVs as the basis for LUT values and the effective comparison of those LUT values to subsequent laboratory sample results, depends heavily on laboratory data of a known and predictable quality that optimizes both precision and sensitivity. USEPA recommends ensuring laboratory data meets the requirements of the project and is produced in a reliable and defensible manner.

For each radionuclide, DTSC should specify a required U_{MR}; see Section 2.1.1 for additional information. The U_{MR} is the primary MQO used to establish decision criteria (the LUT values) for determining if a sample result has exceeded a BTV[7]. When a laboratory result exceeds the corresponding LUT value, data evaluation may conclude within a specified confidence interval that the actual soil activity concentration has exceeded the BTV, therefore requiring remediation. The recommended decision criteria are based on the MQO that results at or above the BTV will have a U_{MR} of no more than 10 percent. This primary MQO, as well as contingency conditions when the primary MQO cannot be met, and other considerations in the procurement and use of laboratory data, are discussed in more detail below.

A specific U_{MR} is the primary MQO to develop a DL.

[7]Other MQOs, such as quality control sample acceptance criteria, are described in the Area IV Radiological Study QAPP (HGL, 2012b) and are intended to support the project data quality objectives.

2.1 LABORATORY SELECTION AND MEASUREMENT QUALITY OBJECTIVES

Before soliciting laboratory services, USEPA recommends that DTSC and DOE form an agreement on the potential scope of the project, including:

- overall remediation schedule
- number and expected collection rate of soil samples for analyses
- radionuclides to be reported (optimally based on USEPA's recommended Priority One radionuclides)
- period of laboratory performance
- expected turnaround-time for analysis and reporting of data in acceptable data packages
- establish achievable MQOs that result in consistent LUT values for the remainder of the project; i.e., remediation and closure phases

In addition, the agreement should include any other parameters that may affect the selection of the laboratory, impact the laboratory's ability to perform, or influence the negotiation of laboratory MQOs. These issues should be discussed in the context of the potential impact on field operations, such as excavation, confirmation sampling, backfilling, and closure, with the goal of establishing coordinated and consistent contracting of laboratory services that minimizes any disparity of data quality or MQOs among laboratories or organizations.

The laboratory selection process should include a thorough review of the laboratory's capabilities to perform the requested analyses, achieve the project MQOs, and deliver the data in a pre-defined format, within a specified schedule. Pre-qualification laboratory audits, and a review of independent performance evaluation results and analyst proficiency reports, are significant proactive steps recommended to ensure the retention of qualified laboratory services.

In all cases, and for all methods and radionuclides, the laboratory should provide a verifiable demonstration of its analytical proficiency prior to the award of a contract. This demonstration should include, at a minimum, the analysis of performance evaluation samples supplied by DTSC, to be analyzed at the project-required MQOs, and to be reported within a specified time frame in the project-required format, including electronic data deliverables, if required.

USEPA recommends selecting a single laboratory that best meets the project requirements, specifically, that meets the MQOs for the Priority One radionuclides to avoid having multiple MDCs. This laboratory is recommended to be used for the analyses of all samples collected during all future phases of investigations, remediation, and closure.

Procurement of a single analytical laboratory should focus on meeting the MQOs for the Priority One radionuclides and on avoiding having multiple MDCs.

Recommendations for establishing MQOs that support the project cleanup goals are discussed in the following sections.

2.1.1 Required Method Uncertainty

In specifying project MQOs, USEPA recommends that the laboratory establish Laboratory Action Levels (LAL) at which the following U_{MR} criteria for each requested radionuclide can be met:

- For results at or below the LAL, the method uncertainty, expressed as a one sigma (1σ) combined standard uncertainty (CSU), should not exceed 10 percent of the LAL.
- For results above the LAL, the CSU should not exceed 10 percent of the reported result.

The preferred LAL is equal to the BTV.

The ability to accurately predict the U_M at the cleanup level is a key principle in the development of LUT values and requires a reliable determination of the LAL.

The analytical Statement of Work should require laboratories to establish an LAL, which is critical to developing LUT values.

The LAL is the activity concentration at which the associated CSU is less than or equal to 10 percent. Results greater than the LAL will have a required relative CSU (ϕ_{MR}) of not more than 10 percent of the result. Results less than or equal to the LAL will have a required CSU (U_{MR}), expressed in activity units, of not more than 10 percent of the LAL. This uncertainty requirement of 10 percent at the LAL should be an MQO that is formally incorporated into the laboratory analytical statements of work. In addition, the laboratory should be required to verify its ability to meet this MQO by performing a method validation study, as described below, prior to performing analyses on project samples.

The MQOs in the analytical SOW should be:

- **Sample results greater than the LAL shall have a relative CSU of no more than 10 percent.**
- **Sample results less than or equal to the LAL shall have a required CSU of not more than 10 percent of the LAL.**

The method validation study should incorporate the principles described in MARLAP, Chapter 6, Section 6.6, and should be performed at Levels C, D, or E, as applicable to the laboratory, to ensure that at least five replicates are prepared at each activity level of interest. Level A and B validation studies should not be accepted, as performance to the SOW itself may be

considered a "New Application". In addition, the three activity concentration levels should be equal to the LAL, one-half the LAL, and twice the LAL. Finally, all results provided in the method validation report should be evaluated against the MQO to ensure that each result meets the method uncertainty requirements, ϕ_{MR} or U_{MR}, as applicable.

This MQO is based on the expectation that LUT values will be calculated and used as exceedance decision criteria, for which the decision error rate does not exceed 5 percent. The laboratory should ensure that all significant sources of uncertainty are accounted for in their reported uncertainty estimates. MARLAP, Chapter 19 has further details related to estimating laboratory uncertainty (USEPA, 2004).

The 10 percent requirement for method uncertainty may require negotiations with the laboratory for extended count times, large sample volumes, or other non-routine method modifications. In all cases, these modifications should be demonstrated to be effective and achievable before finalizing the procurement of laboratory services.

There may be cases in which the 10 percent uncertainty requirement is not practically or technologically achievable at the BTV. In these cases the laboratory should provide an activity level at which it can achieve the 10 percent uncertainty requirement, with the understanding that this activity level will be greater than the BTV. The laboratory should be expected to meet the uncertainty requirement, either at the BTV or at the alternate activity level, in all subsequent results. Failure to do so should be viewed as cause for rejection of the result and reanalysis of the sample.

2.1.2 Minimum Detectable Concentration

As the AOC allows for consideration of the method MDC, as discussed below, the laboratory should declare their method MDCs in advance and those values should be incorporated into the laboratory services agreement. For consistency among laboratories and for comparability of results, the formula for calculating the MDC should be explicitly described in the request for proposals to the prospective laboratories and should be incorporated into the contract for laboratory services.

For each requested radionuclide, and for the analytical conditions under which the U_{MR} requirement is achieved, the laboratory should provide a method MDC that can reasonably be expected to be achieved in subsequent sample analyses.

As discussed above, the method MDC should be effectively demonstrated prior to awarding a contract for laboratory services. This method MDC should be incorporated into the contract for laboratory services and subsequent sample-specific MDCs should generally conform to the overall method MDC.

The analytical SOW should require the laboratory to specify actual method MDCs achieved under the analytical conditions that meet the MQOs; i.e., the U_{MR} requirement before the project commences

2.2 USE OF MINIMUM DETECTABLE CONCENTRATIONS IN PLACE OF BACKGROUND THRESHOLD VALUES

When the laboratory is unable to achieve the U_{MR} requirement of 10 percent at the BTV, alternate decision criteria may become necessary. In cases where the method MDC exceeds the established BTV, the MDC is used in place of the BTV, in compliance with the AOC.

If the laboratory cannot meet the MQO of 10 percent required CSU (U_{MR}) at the BTV, and the laboratory method MDC is greater than the BTV, then the method MDC may be used as the alternate cleanup level.

For purposes of this technical memorandum, and for the appropriate use of BTVs, it is important to note that the MDC is not used as a detection decision criterion. Rather, the MDC is understood to represent a level of activity at which the associated uncertainty becomes predictably constrained to a level that is useful for defining a substitute cleanup value when the BTV is not practically or technologically supported by the laboratory data. The use of the MDC in this case, defined as "the smallest amount of activity that can be quantified for comparison with regulatory limits," is consistent with the AOC requirements and definitions.

2.3 DEVELOPMENT AND USE OF DECISION LEVELS

Decisions regarding the exceedance of the established cleanup levels, whether they are BTVs or method MDCs, should take into account the overall uncertainty of the analytical method, as well as the data user's tolerance for making decision errors. These parameters influence the likelihood that a particular laboratory result is consistent with the true sample concentration (which is impossible to know with 100 percent certainty) in which the BTV has been exceeded.

USEPA understands that LUT values are the limits for reported laboratory results, above which action is required and recommends that LUT values are calculated as follows:

$$\text{LUT value} = \text{Cleanup Level} + 1.645 * U_M$$

Where:

Cleanup Level = the greater of the BTV or the laboratory's method MDC
U_M = the laboratory's method uncertainty for results at the Cleanup Level
1.645 = the normal distribution quantile consistent with 5 percent Type I and Type II decision errors (see MARLAP for additional information)

Attachment 2 contains a flow chart to illustrate the development of LUT values. It is noted that U_M is to be evaluated for each method and for each radionuclide at the established Cleanup Level. The U_M does not include consideration of individual sample-specific uncertainties, which would allow for incorrect decisions to be made based on poor quality data, such as that due to matrix interference or instrument performance problems.

Use the flow chart in Attachment 2 to guide development of DLs as the LUT values.

The USEPA recommends that the correct use of the LUT values is that laboratory results above the LUT values are likely, at the 95 percent confidence interval, to represent an exceedance of the cleanup level. The response to laboratory results above a LUT value is governed by the AOC; that is, the reanalysis of the sample at a longer count time to verify accuracy or remediation followed by confirmation sampling and analysis.

3.0 USE OF THE LOOK-UP TABLE

Table 1 summarizes the results of the background study with the BTVs for the radionuclides of concern. USEPA recommends that DTSC develop the future LUT values required by the AOC using the process outlined in Sections 1 and 2 of this memorandum.

Table 1 is divided into two sections. Section I (Priority One radionuclides) includes only those radionuclides that, during the Area IV Radiological Study, were detected at concentrations exceeding the project RRCs. The RRCs were calculated from sample results obtained from the two contracted production laboratories. The two sigma (97.7 percent confidence level of the standard normal cumulative probability) upper confidence limit (UCL) MDCs calculated from these laboratories are summarized in Table 2 to provide DTSC with a reference point for a reasonable limit for commercially available MDCs.

USEPA recommends that DTSC should contract a laboratory that can meet the MQOs for LUT values equal to or less than the RRCs. RRCs are not appropriate for use as LUT values.

USEPA recommends that DTSC should contract a laboratory that can achieve the lower of the two sigma UCL MDCs presented in Table 2.

Section II (Priority Two radionuclides) includes those radionuclides that were not detected at concentrations exceeding the RRCs. Some of these radionuclides are Naturally Occurring Radioactive Material (NORM). During the USEPA's Area IV Radiological Study most of the analytical results that exceeded the DLs for NORM radionuclides of concern were evaluated and determined as not attributable to site-related activities. However, several NORM radionuclides were suspected as potential site-related activities and are included in Section I. Future results that exceed an LUT value for NORM will require careful evaluation to determine if the result is attributable to site-related activities.

USEPA recommends focusing analytical efforts on the radionuclides in Section I (Priority One radionuclides). This is expected to reduce analytical costs, accelerate the delivery of analytical data, and optimize overall data quality while achieving a cleanup closer to the BTVs by allowing the laboratory to focus its analytical resources on the most important radionuclides of concern. The method MDCs and the LUT values in Table 1 cannot be determined until after the final procurement of laboratory services. Table 3 provides a more detailed worksheet, including the formula for calculating LUT values using values derived from a hypothetical

contract laboratory, and the required inputs from the laboratory procurement effort, which may be helpful in completing Table 1.

The BTVs in the LUT are displayed to three significant figures, which is consistent with the American National Standards Institute (ANSI) N42.23 recommendations for significant figures, and is believed to be generally appropriate for the quality of data generated in the background study (ANSI, 1996). A review of the process used to develop DLs indicates that three significant figures are appropriate for those values as well. USEPA recommends reporting the LUT values to three significant figures, after they are calculated.

In the decision making process of comparing sample results obtained during future investigations, remediation, and closure to the LUT values, USEPA recommends that LUT values are established as described in this memorandum. Once the LUT values are established by DTSC then individual sample results can be compared to the respective LUT values. If the individual sample result is equal to or greater than the LUT values then the sample is considered contaminated, thus requiring remediation, else the sample is considered not contaminated, thus not requiring remediation. Direct comparison of sample results to the BTVs, RTLs or RRCs is inappropriate. USEPA recommends that DTSC develop LUT values by following the process outlined in this memorandum.

A sample is only considered contaminated if the sample result is equal to or greater than the respective LUT value, which DTSC will develop after procurement of laboratory services.

Comparing sample results to BTVs, RTLs, or RRCs is NOT appropriate because those values do not represent applicable LUT values.

4.0 RECOMMENDATIONS

USEPA recommends using the BTVs in the development of LUT values for all future phases of investigation, remediation, and closure of the Area IV Study Area. In cases where the laboratory analytical data does not support the use of BTVs in the decision making process, specifically where the laboratory's MDC is greater than the BTV, that MDC should be used as an alternate cleanup level.

USEPA recommends establishing LUT values, to be used as decision-making criteria to determine whether the laboratory result supports a conclusion that the BTV has been exceeded for each radionuclide of concern.

USEPA recommends focusing the list of radionuclides analyzed by the laboratory to those that have been detected at concentrations above the respective RRCs in the Area IV Radiological Study (Priority One radionuclides).

USEPA recommends that a single laboratory is used for the development of the LUT values to avoid multiple MDCs and for analyses of all samples collected from all future phases of investigation, remediation, and closure of the Area IV Study Area.

Finally, USEPA recommends that a rigorous procurement process to obtain a single high quality analytical laboratory services may have advantages as summarized in this technical memorandum. As the majority of contamination is either cesium-137 or strontium-90, the analytical services contract should clearly state that the evaluation score will be weighted higher for responses that provide evidence of meeting the MQOs at or closest to the BTV value for those radionuclides. In addition, higher scores may be given to the strontium-90 analysis, since achieving the MQOs near the BTV is more technically challenging.

5.0 REFERENCES

American National Standards Institute (ANSI) N42.23-American National Standard Measurement and Associated Instrument Quality Assurance for Radioassay Laboratories, 1996, IEEE, New York, New York. August

Department of Toxic Substances Control (DTSC), 2010. Administrative Order On Consent For Remedial Action, Santa Susana Field Laboratory, Simi Hills, Ventura County, California. December.

HydroGeoLogic, Inc. (HGL), 2011. Final Radiological Background Study Report, Santa Susana Field Laboratory, Ventura County, California. October.

HGL, 2012b, Final Quality Assurance Project Plan for Soil Sampling, Area IV Radiological Study, Santa Susana Field Laboratory, Ventura County, California, Revision 01. March.

U.S. Environmental Protection Agency (USEPA), et. al., 2004, Multi-Agency Radiological Laboratory Analytical Protocols Manual, EPA-402-B-04-001A. July.

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ATTACHMENT 1

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Table 1
Example Lookup Table

Radionuclide	Symbol	BTV	Method MDC	LUT Values
Section I: Priority One Radionuclides [1]				
actinium-228	Ac-228	2.30	[2]	[2]
bismuth-212	Bi-212	2.04	[2]	[2]
bismuth-214	Bi-214	1.57	[2]	[2]
cesium-137+D	Cs-137	0.193	[2]	[2]
cobalt-60	Co-60	0.00556	[2]	[2]
europium-152	Eu-152	0.0169	[2]	[2]
lead-212	Pb-212	2.67	[2]	[2]
lead-214	Pb-214	1.68	[2]	[2]
nickel-59	Ni-59	0.344	[2]	[2]
plutonium-239/240	Pu-239/Pu-240	0.0142	[2]	[2]
strontium-90+D (Y-90)	Sr-90	0.0750	[2]	[2]
thallium-208	Tl-208	0.923	[2]	[2]
thorium-230	Th-230	2.04	[2]	[2]
thorium-234	Th-234	3.04	[2]	[2]
uranium-233/234	U-233/U-234	1.87	[2]	[2]
uranium-235+D/236	U-235/U-236	0.130	[2]	[2]
uranium-238+D	U-238	1.68	[2]	[2]
Section II: Priority Two Radionuclides [1]				
actinium-227+D	Ac-227	0.127	[2]	[2]
americium-241	Am-241	0.0162	[2]	[2]
americium-243+D	Am-243	0.0134	[2]	[2]
antimony-125+D	Sb-125	0.321	[2]	[2]
cadmium-113m	Cd-113m	2,950	[2]	[2]
carbon-14	C-14	2.54	[2]	[2]
cesium-134	Cs-134	0.0300	[2]	[2]
curium-243/244	Cm-243/Cm-244	0.0147	[2]	[2]
curium-245/246	Cm-245/Cm-246	0.0162	[2]	[2]
curium-247/248	Cm-247/Cm-248	0.0234	[2]	[2]
europium-154	Eu-154	0.0251	[2]	[2]
europium-155	Eu-155	0.198	[2]	[2]
holmium-166m	Ho-166m	0.0365	[2]	[2]
iodine-129	I-129	2.08	[2]	[2]
neptunium-236	Np-236	0.0314	[2]	[2]
neptunium-237+D	Np-237	0.0109	[2]	[2]
neptunium-239	Np-239	0.0427	[2]	[2]

Table 1
Example Lookup Table (Continued)

Radionuclide	Symbol	BTV	Method MDC	LUT Values
Section II: Priority Two Radionuclides[1] (Continued)				
nickel-63	Ni-63	0.452	[2]	[2]
niobium-94	Nb-94	0.0165	[2]	[2]
plutonium-236	Pu-236	0.0184	[2]	[2]
plutonium-238	Pu-238	0.00425	[2]	[2]
plutonium-241	Pu-241	0.349	[2]	[2]
plutonium-244+D	Pu-244	0.00156	[2]	[2]
potassium-40	K-40	30.5	[2]	[2]
promethium-147	Pm-147	4.96	[2]	[2]
protactinium-231	Pa-231	0.791	[2]	[2]
radium-226+D	Ra-226	1.88	[2]	[2]
sodium-22	Na-22	0.00787	[2]	[2]
technetium-99	Tc-99	0.368	[2]	[2]
thorium-228+D	Th-228	3.67	[2]	[2]
thorium-229+D	Th-229	0.0462	[2]	[2]
thorium-232	Th-232	2.95	[2]	[2]
thulium-171	Tm-171	65.9	[2]	[2]
tin-126	Sn-126	0.00490	[2]	[2]
tritium (H-3) organic	H-3	7.38	[2]	[2]

Notes:
[1]Determined during USEPA's Area IV Radiological Study based on comparison to the project Radiological Reference Concentrations.
[2]To be entered after laboratory procurement is completed.
All units reported in picocuries per gram.
BTV – background threshold value
+D – plus daughters
LUT – look-up table
MDC – minimum detectable concentration

Table 2
Background Threshold Values and Two Sigma Upper Confidence Level Minimum Detectable Concentrations of USEPA's Contract Laboratories

Radionuclide	Symbol	BTV	Laboratory A Two Sigma UCL MDC[1]	Laboratory B Two Sigma UCL MDC[1]
Section I: Priority One Radionuclides[2]				
actinium-228	Ac-228	2.30	0.135	0.108
bismuth-212	Bi-212	2.04	0.220	0.163
bismuth-214	Bi-214	1.57	0.0419	0.0315
cesium-137+D	Cs-137	0.193	0.0251	0.0198
cobalt-60	Co-60	0.00556	0.0252	0.0228
europium-152	Eu-152	0.0169	0.0670	0.0459
lead-212	Pb-212	2.67	0.0497	0.0319
lead-214	Pb-214	1.68	0.0479	0.0317
nickel-59	Ni-59	0.344	7.24	0.648
plutonium-239/240	Pu-239/Pu-240	0.0142	0.0369	0.00664
strontium-90+D (Y-90)	Sr-90	0.0750	0.387	0.0677
thallium-208	Tl-208	0.923	0.0255	0.0213
thorium-230	Th-230	2.04	0.123	0.0156
thorium-234	Th-234	3.04	0.426	0.222
uranium-233/234	U-233/U-234	1.87	0.0997	0.0172
uranium-235+D/236	U-235/U-236	0.130	0.0751	0.0149
uranium-238+D	U-238	1.68	0.0718	0.0143
Section II: Priority Two Radionuclides[2]				
actinium-227+D	Ac-227	0.127	0.267	0.169
americium-241	Am-241	0.0162	0.0410	0.0141
americium-243+D	Am-243	0.0134	0.0372	0.00686
antimony-125+D	Sb-125	0.321	0.0695	0.0502
cadmium-113m	Cd-113m	2,950	178	47.5
carbon-14	C-14	2.54	0.998	0.0983
cesium-134	Cs-134	0.0300	0.0231	0.0688
curium-243/244	Cm-243/Cm-244	0.0147	0.0466	0.0162
curium-245/246	Cm-245/Cm-246	0.0162	No Data	0.0123
curium-247/248	Cm-248	0.0234	No Data	0.0110
europium-154	Eu-154	0.0251	0.136	0.125
europium-155	Eu-155	0.198	0.0949	0.0438
holmium-166m	Ho-166m	0.0365	0.0362	0.0302
iodine-129	I-129	2.08	0.525	No Data
neptunium-236	Np-236	0.0314	0.0495	0.0368
neptunium-237+D	Np-237	0.0109	0.0542	No Data

Table 2
Background Threshold Values and Mean Minimum Detectable Concentrations of USEPA's Contract Laboratories (Continued)

Radionuclide	Symbol	BTV	Laboratory A Two Sigma UCL MDC[1]	Laboratory B Two Sigma UCL MDC[1]
Section II: Priority Two Radionuclides[2] Continued				
neptunium-239	Np-239	0.0427	0.177	0.102
nickel-63	Ni-63	0.452	1.78	0.843
niobium-94	Nb-94	0.0165	0.0213	0.0172
plutonium-236	Pu-236	0.0184	0.0510	0.0107
plutonium-238	Pu-238	0.00425	0.0480	0.00921
plutonium-241	Pu-241	0.349	3.73	No Data
plutonium-244+D	Pu-244	0.00156	0.0259	0.00526
potassium-40	K-40	30.5	0.213	0.186
promethium-147	Pm-147	4.96	8.62	No Data
protactinium-231	Pa-231	0.791	1.11	0.693
radium-226+D	Ra-226	1.88	0.151	No Data
sodium-22	Na-22	0.00787	0.0306	0.0295
technetium-99	Tc-99	0.368	1.75	0.387
thorium-228+D	Th-228	3.67	0.183	0.0300
thorium-229+D	Th-229	0.0462	0.135	0.0165
thorium-232	Th-232	2.95	0.0877	0.0139
thulium-171	Tm-171	65.9	23.0	7.63
tin-126	Sn-126	0.00490	0.0233	0.0195
tritium (H-3) organic	H-3	7.38	9.99	0.284

Notes:
[1]Two Sigma UCL MDCs represent a benchmark for expected limits of achievable MDCs by commercial laboratories. Two Sigma UCL MDCs were calculated from 3,772 sample results from USEPA's Area IV Radiological Study. Datasets for calculating the two sigma UCL MDCs ranged from 14 to 2,464 samples, depending on the radionuclide and laboratory.
[2]Determined during USEPA's Area IV Radiological Study based on comparison to the project Radiological Reference Concentrations.
[3]Less than 50 results were used in the calculation of the two sigma UCL MDCs, thus use of this value warrants caution.
All units reported in picocuries per gram.
BTV – background threshold value
+D – plus daughters
MDC – minimum detectable concentration
Two Sigma UCL – two sigma (97.7 percent confidence level of the standard normal cumulative probability) upper confidence limit (UCL)

Table 3
Example Worksheet for Determining Project Decision Levels

Background Study[1]			Example Laboratory Contract[2]		Development of Example LUT Levels[3]		
Radionuclide	**Symbol**	**BTV**	**Laboratory Activity Meeting a 10% Uncertainty[4]**	**Laboratory Method MDC**	**Cleanup Level**	**Estimated Uncertainty at Cleanup Level**	**Example LUT Values**
	Column:	C	D	E	F	G	H
	Equation:				=MAX(C,E)[5]	=IF(F>D,0.1*F,0.1*D)[5]	=F+(1.645*G)[5]
cesium-137+D	Cs-137	0.193	0.0727	less than BTV	0.193	0.0193	0.225
cobalt-60	Co-60	0.00556	0.0889	0.0240	0.0240	0.00889	0.0387

Notes:

[1]Values derived from the USEPA's Radiological Background Study.

[2]Values represent example values derived from a hypothetical contract laboratory and provided for illustrative purposes only. These values must be replaced with actual values from the contracted laboratory.

[3]Example LUT values are derived from the example values of the hypothetical laboratory. These values are calculated automatically after updated values are entered in the "Example Laboratory Contract" columns.

[4]Uncertainty is defined as the one sigma combined standard uncertainty. Uncertainty requirement is 10 percent when a value is equal to the BTV.

[5]Equations represent a formula to be entered into the rows below. Letters denote the respective column to be used in the formula.

All units reported in picocuries per gram.

BTV – background threshold value

+D – plus daughters

LUT – look-up table

MDC – minimum detectable concentration

ATTACHMENT 2

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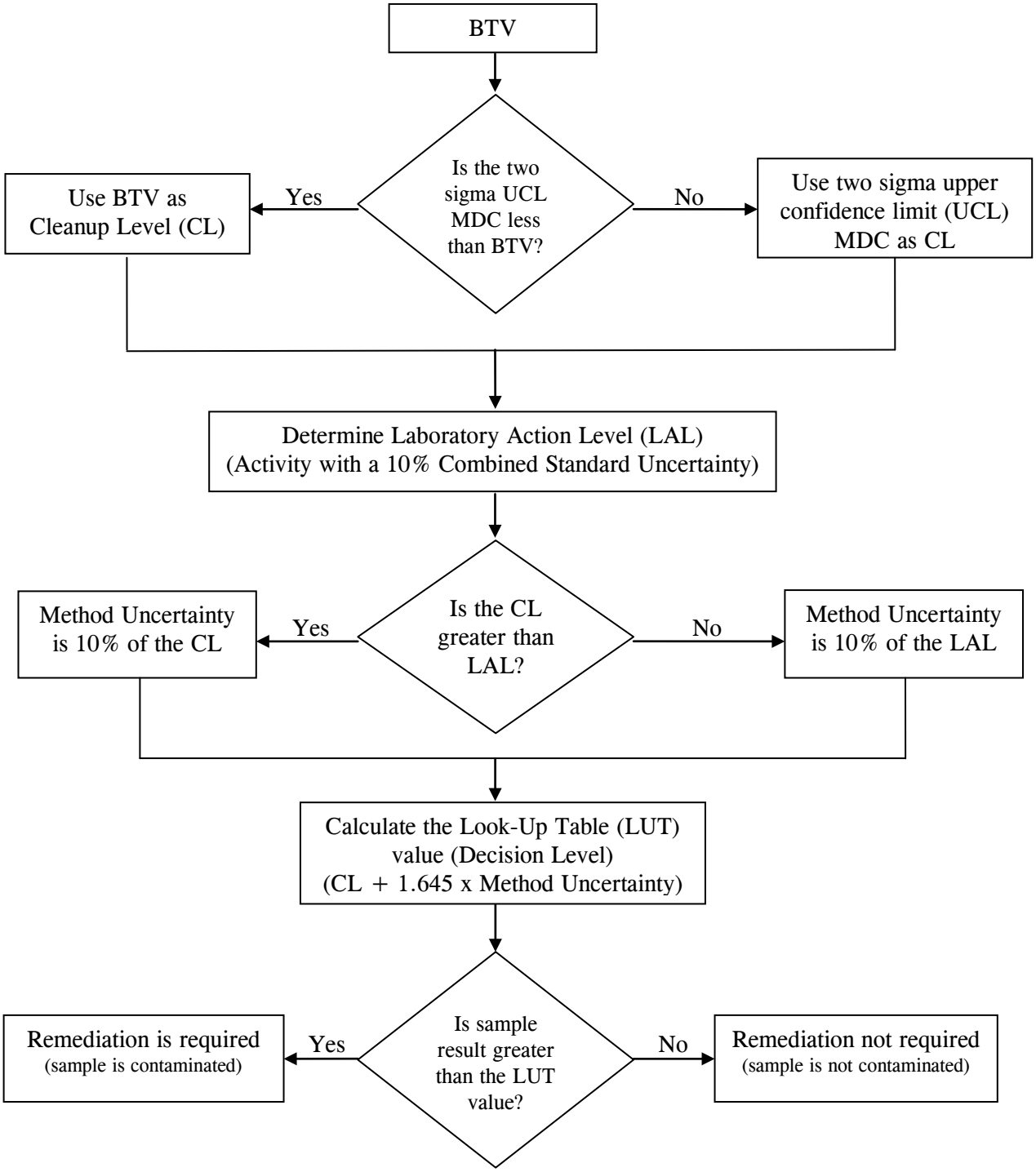
Development of Lookup Table Decision Levels


BTV
Is the two sigma UCL MDC less than BTV?
Yes
No
Use BTV as Cleanup Level (CL)
Use two sigma upper confidence limit (UCL) MDC as CL
Determine Laboratory Action Level (LAL) (Activity with a 10% Combined Standard Uncertainty)
Is the CL greater than LAL?
Yes
No
Method Uncertainty is 10% of the CL
Method Uncertainty is 10% of the LAL
Calculate the Look-Up Table (LUT) value (Decision Level) (CL + 1.645 x Method Uncertainty)
Is sample result greater than the LUT value?
Yes
No
Remediation is required (sample is contaminated)
Remediation not required (sample is not contaminated)